SOCIETY OF ACTUARIES

Life ALM and Modeling

Exam ILALAM

Date: Thursday, May 6, 2021

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 4 questions numbered 1 through 4 with a total of 40 points.

   The points for each question are indicated at the beginning of the question.

2. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions provided in this document.

Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel document as directed within each question. Graders will only look at work in the indicated file.

   a) In the Word document, answers should be entered in the box marked ANSWER within each question. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1, and x^2 can be typed as x^2.

   b) In the Excel document formulas should be entered. For example, X = component1 + component2. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit.

   c) Individual exams may provide additional directions that apply throughout the exam or to individual items.

2. The answer should be confined to the question as set.

3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.

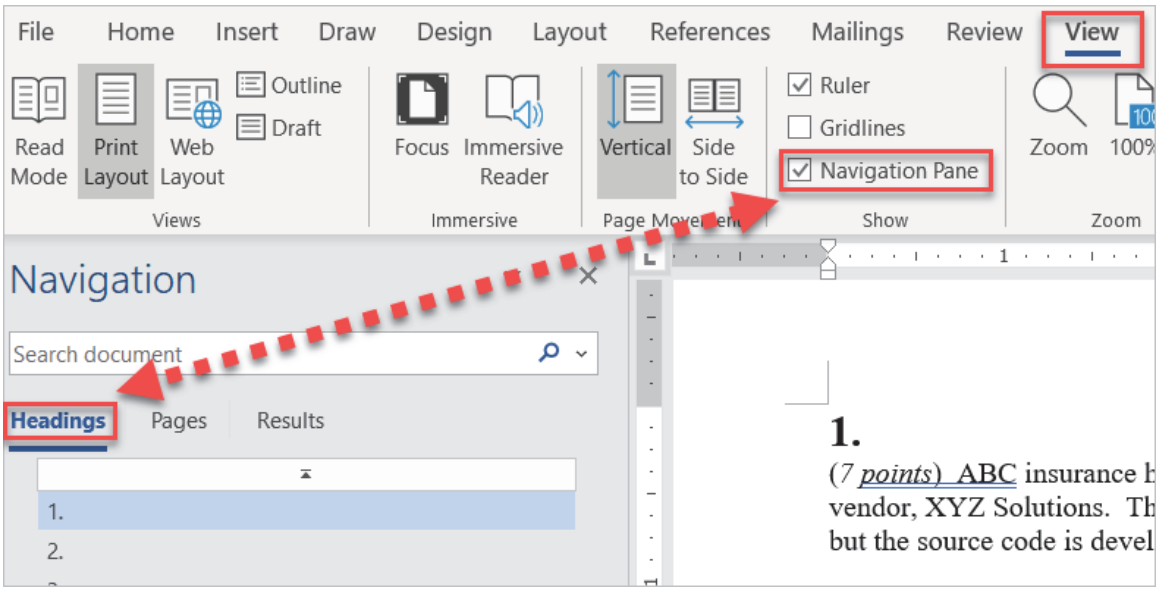
4. The Word and Excel documents that contain your answers must be uploaded before time expires.

Recognized by the Canadian Institute of Actuaries.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:



1.

(*10 points*) Your company carries a material VA block with GMIB, GMDB and GMWB riders. In preparation for the recent regulatory changes towards Stat VM-21 and ASU 2018-12 - Targeted Improvements to the Accounting for Long-Duration Contracts, your company is developing a nested stochastic framework to model this VA block.

(a) (*6 points*) Critique the following proposals or statements. Justify your answer.

A. VM-20 AAA stochastic log volatility scenarios are good for setting the outer loop of the nested stochastic framework.

ANSWER:

B. The outer loop's scenarios are retrospective and should be strictly calibrated to historical data to produce realistic paths for economic variables.

ANSWER:

C. The expected 1-year risk-free rates listed below suggest the nested scenarios are properly calibrated:

Projection Year	**1**	**2**	**3**	**4**	**5**
Outer Loop	3%	3%	4%	3%	3%
Inner Loop	2%	1%	2%	2%	2%

ANSWER:

D. The new Stat and GAAP standards create increased needs in hedging, especially for GMIB riders.

ANSWER:

1. Continued

E. If a GMAB rider is added to this product, the nested stochastic framework needs to be redesigned.

ANSWER:

F. CTE based measurements are far superior to VaR based measurements for stochastic modeling.

ANSWER:

(b) (*2 points*) The stochastic simulation was performed twice, once without hedging and once with hedging. Resulting worst Greatest Present Value of Accumulated Deficiencies (GPVAD) are provided below:

GPVAD	Without Hedging	With Hedging
CTE 70	480	350
CTE 98	920	650

(i) Calculate the capital required, ignoring the deterministic reserve floor. Show all work.

The response for this part is to be provided in the Excel document

(ii) Calculate the total asset requirement (TAR) under the statutory view assuming a hedge effectiveness ratio of 80%. Show all work.

The response for this part is to be provided in the Excel document

1. Continued

(c) (*2 points*) Your company is considering acquiring a block of Term Life business and wishes to assess the mortality risk through a stochastic valuation. You are given:

	Present value of future cash flow deviations from the best estimate scenario		
Percentile	**Underwriting**	**Volatility**	**Catastrophe**
95%	-280	-59	-431
90%	-250	-43	-320
75%	-120	-20	-152
25%	186	32	101
10%	210	38	135
5%	267	46	240

Analyze the reasonableness of the initial results presented above, from a stochastic modeling perspective. No calculations are required for this question.

ANSWER:

2.

(*12 points*)

(a) (*2 points*) Describe the four main approaches by which a company can address its Asset Liability Management (ALM) needs.

ANSWER:

MRK Life is a company writing long duration interest-sensitive insurance policies.

(b) (*4 points*)

(i) (*1 point*) Explain why MRK might want to minimize surplus volatility instead of minimizing asset-only volatility in their ALM practice.

ANSWER:

(ii) (*1 point*) You are given the following information on MRK Life's balance sheet:

	Market Value	**Effective Duration**
Assets	1,000	10
Liability	800	15

Assume a -0.5% parallel shift in the interest rate curve. Calculate the change to MRK's surplus. Show all work.

The response for this part is to be provided in the Excel document

(iii) (*2 points*) You are given the following information on two types of interest rate hedging instruments available in the market:

Hedging Instrument	**Notional**	**Effective Duration**
Swap 1	100	15
Swap 2	100	-10

Recommend a suitable hedging portfolio using the above swaps to minimize the surplus volatility solved for in part (ii). Show all work.

The response for this part is to be provided in the Excel document

2. Continued

(c) (*2 points*) MRK is considering the following two bond portfolios:

	Market Value of Zero-Coupon Bonds			Effective Duration
	10-year	**20-year**	**30-year**	
Portfolio 1	100	100	400	25
Portfolio 2	0	300	300	25

Interest rates experience the following change:

Rate	Change
10-year	+0.05
20-year	+0.1
30-year	-0.05

Calculate the change in return for each portfolio. Show all work.

The response for this part is to be provided in the Excel document

2. Continued

(d) (*4 points*) Critique each of the following statements related to MRK's annual asset adequacy analysis:

A. Asset adequacy analysis is purely a required regulatory exercise and provides no other value to MRK.

ANSWER:

B. Either cash flow testing or gross premium valuation would be appropriate to use for MRK's asset adequacy analysis.

ANSWER:

C. A projection period of 20 years is adequate for MRK's analysis.

ANSWER:

D. The current interest rate environment should not influence MRK's opinion on asset adequacy.

ANSWER:

Critique each statement.

3.

(*8 points*) You have been asked to review the inflation assumptions used in scenario testing for a company that sells two products: participating whole life insurance and single premium annuity. You have been given the following modeling processes:

- For the participating whole life product
    - Stress testing is conducted once a year to assess the sensitivity of liabilities to various economic scenarios.
    - The current model was developed two years ago by an external consultant.
    - A regime switching model is used to generate 100 sets of projected inflation rates.
    - A second regime switching model is used to project interest rates. The inflation rate in each future year is used to determine the probability of switching between "low", "medium" and "high" government yield regimes.
    - In total 10,000 inflation/interest scenarios are generated.
    - All other assumptions remain unchanged for these scenarios.
- For the single premium annuity product
    - 75% of policies sold have an inflation-indexed payment amount, with the annual inflation rate set equal to the average CPI rate over the past 2 years.
    - Stress testing is conducted quarterly to assess the sensitivity of liabilities to various inflation scenarios.
    - The current model was developed 5 years ago by in house staff.
    - A first order auto-regressive model is used to generate 200 inflation scenarios.
    - All other assumptions remain unchanged for these scenarios.

(a) (*4 points*) Critique the following statements pertaining to the given inflation assumptions:

A. A regime switching model is used for inflation where the rate of inflation at any point is an autoregressive process, but the dynamics are dictated by the prevailing regime.

ANSWER:

3. Continued

B. It is reasonable to assume that inflation is the only parameter that changes for each scenario modeled for both products.

ANSWER:

C. The number of scenarios for the Payout Annuities is reasonable.

ANSWER:

D. The relationship between inflation and investment returns is reasonable.

ANSWER:

(b) (*4 points*) Recommend changes to the modeling processes for both products in order to better manage the interest rate risk.

ANSWER:

4.

(*10 points*) The pricing team at your company has designed a Segregated Fund product offering a Guaranteed Minimum Surrender Benefit. The guarantee allows the policyholder to surrender their contract at the end of each year and receive their time zero account value or the current account value, whichever is greater.

(a) (*3 points*) Using the following assumptions:

Risk Free Force of Interest	8%
Account Value at time 0	10,000
Account Value at time 1	7,000 or 11,000

Calculate the cost of a replicating portfolio that immunizes market risk over a 1-year period. Assume a no arbitrage market.

The response for this part is to be provided in the Excel document

Your company begins selling this product and charges a Management Fee of 3%, collected at the beginning of each year. You hedge the guarantee by purchasing 1-year put options at the beginning of each year.

Using the following assumptions for a single policyholder:

Risk Free Force of Interest	8%
Account Value at time 0	10,000
Real World Return (per year with equal probability)	+10% or -5%
Volatility	10%
Price per 1,000 notional of an at the money Put Option	96.9

You are given the following values from a N(0,1) table:

d	**0.06**	**0.15**	**0.16**	**0.20**	**0.26**	**0.30**	**0.52**	**0.62**
N(d)	0.5239	0.5596	0.5636	0.5793	0.6026	0.6179	0.6985	0.7324
N(-d)	0.4761	0.4404	0.4364	0.4207	0.3974	0.3821	0.3015	0.2676

(b (*7 points*) Calculate the expected cumulative Profit or Loss if the policyholder surrenders their policy at the end of year 2.

The response for this part is to be provided in the Excel document

****END OF EXAMINATION****